SECTION IV

SOVIET REACTIVE SELF-FIRING SYSTEMS 1946-2000 YEARS

Chapter 1

140mm turbojet systems

In 1952, the BM-14 installation, created in the SKV MOP under the leadership of designer V.P. Barmin, firing M-14 turbojet projectiles, was put into service. The BM-14 (8U32) combat vehicle had a chassis from the ZIS-151 vehicle. (Fig. 120, 121, 122),

The system was intended to equip the jet divisions of the combined arms formations of the ground forces. Its distinctive features: high maneuverability; short time to prepare a salvo; rather high fire potential of destruction of such objects as manpower and fire weapons located openly and in lightly armored vehicles, artillery batteries of towed guns, mortar units in concentration areas and in positions, as well as the destruction of light field fortifications.

Structurally, the launchers were smooth-walled pipes with a diameter of 140.3 mm, open at both ends. Contact levers, front and rear stoppers were mounted on the pipes. Truss (package of guides, cradle) - welded construction. It was installed in the bearings of the swing frame brackets and, together with the barrels, formed the swinging part of the combat vehicle. The truss consisted of a front and rear frame and transverse tubes. Swivel mechanism of worm type. The lifting mechanism is screw type. The push-type balancing mechanism is designed to reduce the force on the handle of the lifting mechanism drive.

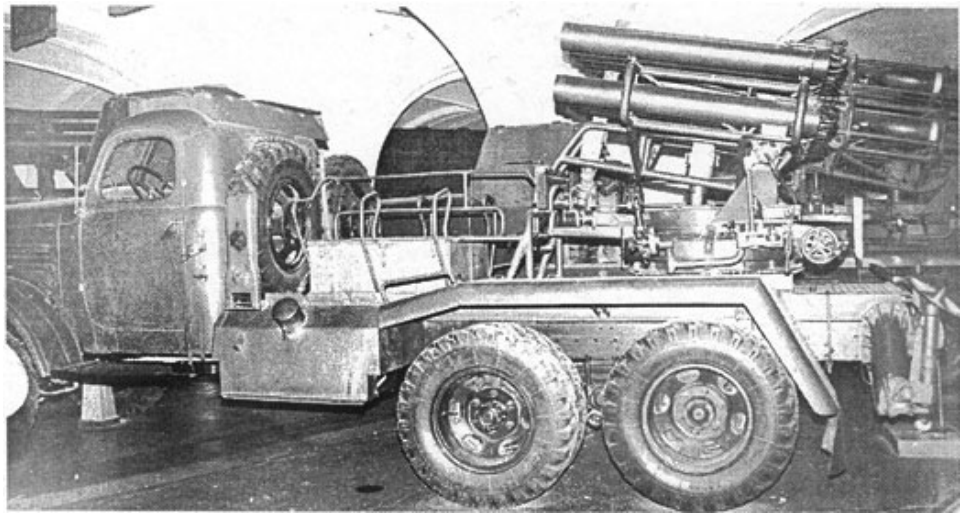


Fig. 120. Fighting vehicle BM 14

Fig. 121. Combat vehicle BM-14 (rear view)

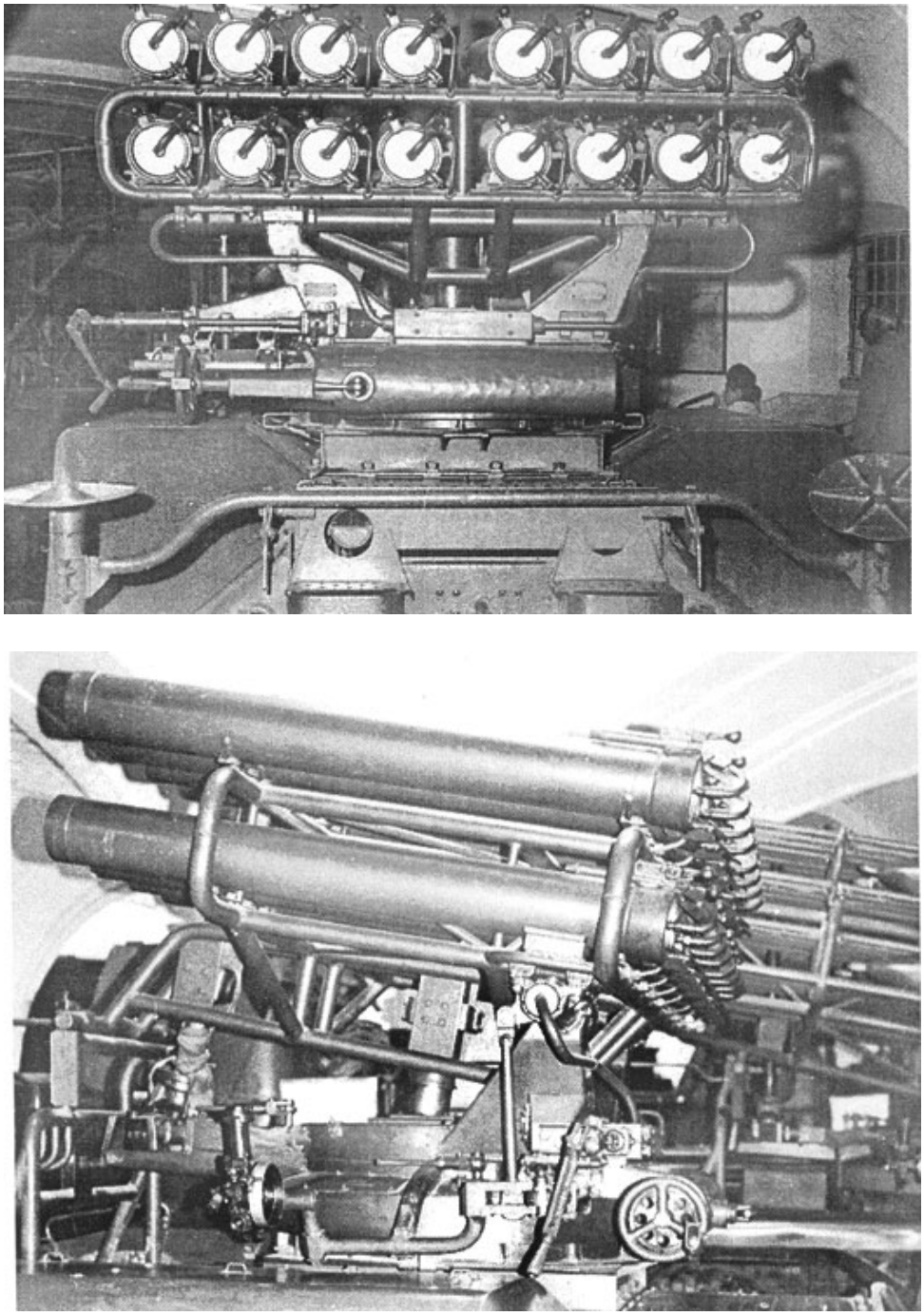


Fig. 122. Fighting vehicle BM-14 (artillery, part)

The swivel frame with a truss installed on it, guidance mechanisms and a balancing mechanism was a rotating part of the installation. The swivel frame, under the action of the swivel mechanism, rotated on a pedestal, on which it rested with three vertical rollers. Six horizontal rollers centered the rotation of the swing frame and kept it from tipping over.
There was a remote control coil for firing at a distance of up to 60 m from the combat vehicle.
BM-14 had a mechanical panoramic sight with a drum, also equipped with a side level.
The M-14-OF turbojet high-explosive fragmentation projectile consisted of a head and missile parts. The rocket part consisted of a chamber, a powder charge, an igniter, a diaphragm, a nozzle bottom and a candle. The powder charge consisted of seven cylindrical single-channel sticks of nitroglycerin powder. The igniter is designed to ignite the powder charge. It consisted of 40 g of smoky gunpowder, encased in an aluminum casing. The diaphragm prevented the release of unburned parts of the powder charge through the nozzle holes and, together with the safety disk of the igniter, kept the checkers of the powder charge from moving in the chamber. The diaphragm is fixed in the nozzle bottom with two screws. Stabilization of the projectile in flight was achieved by its rotation due to the outflow of powder gases through 10 inclined holes, done in the nozzle bottom of the projectile at an angle of 22 ° to its longitudinal axis. (Fig. 123)

Since the minimum firing range of M-14 projectiles was about 7,500 m, rings were put on the projectile to slow it down in flight to fire at shorter distances.
With a small ring, the flight range was from 7550 to 5400 m, and with a large one - from 5420 to 1000 m. The probable deviation of the M-14-OF projectile at the maximum range without a ring was: at a range of 30 m and a lateral 85 m.

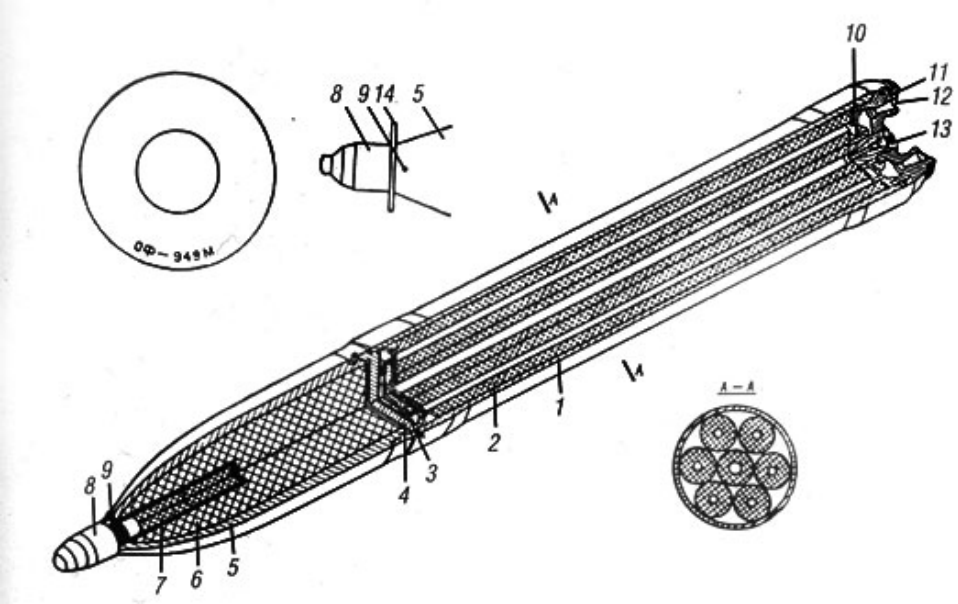


Fig. 123. Turbojet high-explosive fragmentation projectile M-14-OF:
1 - rocket chamber;
2 - powder charge;
3 - igniter;
4 - bottom;
5 - head body;
6 - explosive charge;
7 - additional detonator;
8 - fuse;
9 - locking screw;
10 - diaphragm;
11 - nozzle bottom;
12 - sealing ring;
13 - candle;
14 - brake ring

In addition to the M-14-OF, the BM-14 was equipped with an M-14D smoke shell filled with yellow phosphorus. And in 1955, the M-14 chemical projectile was adopted.
During operation, the BM-14 installation received new chassis. This was reflected in the installation indices - BM-14M (2B2) on a ZIL-157 and B-14MM (2B2R) on a ZIL-131. The artillery unit did not change when the chassis was replaced. The weight of the BM-14M was 8080 kg, and the BM-14MM was 9340 kg. Dimensions of the BM-14M combat vehicle in the stowed position: width 2330 mm, height 2560 mm. Machine height at maximum elevation angle 3045 mm. For the BM-14MM combat vehicle, the dimensions in the stowed position were: width 2500 mm, height 2750, height at a maximum elevation angle of 3230 mm.
In 1958, under the leadership of chief designer A.I. Yaskin, a new 140-mm launcher BM-14-17 (8U36) was created on the basis of the GAZ-63 or GAZ-63A vehicle. The chassis of the GAZ-63 car differed from the GAZ-63A only by the presence of a winch installed at the front end of the frame in front of the radiator and driven by the car engine.
The number of pipes increased by one, but the weight of the launcher decreased by almost 3 tons. The block of barrels in BM-14-17, unlike BM-14, was placed not in a truss, but in a cradle, which was a rigid welded box and formed a swinging part of the installation. The cradle was installed on a base similar to the machine tool of an artillery gun.
The rotary mechanism served for horizontal aiming of the barrels in the range from -33 ° 30 'to + 166 ° 30' from the main direction of the combat vehicle's firing.
The main direction of firing of the combat vehicle (76 ° from the longitudinal axis of the vehicle on the left side) was determined by aligning the pointers on the pin and the pin casing.

The swivel mechanism consisted of a worm and a worm wheel mounted on a pinion shaft, which are mounted on a rotating part, and a main wheel mounted on a stationary part.
The lifting mechanism is screw type. With the help of a lifting mechanism, the trunks could be given elevation angles from 0 ° to + 50 ° in sectors ± 33 ° 30 'and from + 119 ° 30' horizontal fire (from the main direction of fire); in the sector from + 33 ° 30 'to + 119 ° 30' of horizontal shelling, the trunks can be given elevation angles from + 19 ° to + 50 °.
The balancing mechanism is spring, pushing type, served to reduce the effort on the handle of the flywheel drive of the lifting mechanism.
The base had a massive pin mounted on bearings in a special casing. The shroud was welded to the vehicle chassis.
Ammunition remains the same.
Combat vehicles BM-14, BM-14M, BM-14-MM and BM-14-17 were in service with rifle divisions. From 1948 to 1953, the second artillery regiment with combat vehicles of the BM-14 type was included in these divisions. The regiment had three divisions of three-battery composition, each battery consisted of four combat vehicles; a total of 36 combat vehicles per regiment.
In addition, the launcher from the BM-14-17 (8U36) was installed on the river armored boats of the project 1204.
In the mid-50s, a towed 16-barreled launcher RPU-14 for M-14 missiles was developed at GSOKB-43. Prototypes of RPU-14 passed factory tests during 1956. And from May 3 to June 27, 1957, two RPU-14 successfully passed field tests. In the course of field tests, both installations passed 3000 km on a GAZ-63 car trailer. (Fig. XXXV color insert)
RPU-14 is mounted on the carriage of the 85-mm D-44 divisional gun. The swinging part of the installation consists of 16 pipes (trunks) and a welded cradle, which is connected to the upper machine with two pins. A sector-type lifting mechanism and a screw-type rotary mechanism are mounted on the upper bed. The installation has a panoramic mortar sight MP-46M.

Table 64

140mm Launcher Data

Launcher name	BM-14	BM-14-17	RPU-14
GAU index	8U32	8U36	8U38
Transport base	ZIL-151	GAZ-63 or GAZ-63A	85mm gun carriage
Number of guides	16	17	16
Barrel caliber, mm	140.3	140.3	140.3
Length of guides, mm	1370	1100	1150
Angle of vertical guidance, degrees	0 °; + 50 °	0 °; + 50 °	0 °; + 50 °
Horizontal guidance angle, degrees	140 °	see text	20 °
Installation dimensions in the stowed position, m: length width height	 6.92 2.30 2.65	 5.43 2.05 2.31	 4.14 1.73 1.45
Barrel weight, kg	24	12	?
Artillery unit weight, kg	2120	1332	?
Uncharged weight (without calculation), kg	7000	4200	925
Weight of the charged installation, kg	8200	5500	1560
Transition time from the traveling position, min	1.5-2	1.5-2	one
Loading time, min	1.5-2	1.5	1.5
Volley duration, s	7-10	7-10	7-10
Maximum speed of movement on the highway, km / h	60	65	65

The bottom machine with suspension is a steel semi-casting, inside of which the torsion suspension and leveling mechanism are assembled. The bottom machine is the base of the rotating part of the launcher. Tubular beds with constant openers are pivotally connected to the lower machine.
The suspension is torsion bar, it is switched on and off automatically during the convergence and spreading of the beds.
The wheels were taken from a GAZ-AA truck with a GK tire and a hub from a D-44 cannon.

The launcher can be transported by aircraft and dropped by parachute in available containers.
RPU-14 is towed by cars or tractors, and for short distances - by the forces of the gun crew. To roll the installation manually, a special roller is placed under the trunk part, which is fixed in the stowed position and transported on the stands.
The firing of the RPU-14 installation is controlled using a remote control panel from a distance of 50-60 m from the installation.
RPU-14 took part in dozens of local conflicts, its combat use continues to this day.

Table 65

140mm Rockets Data

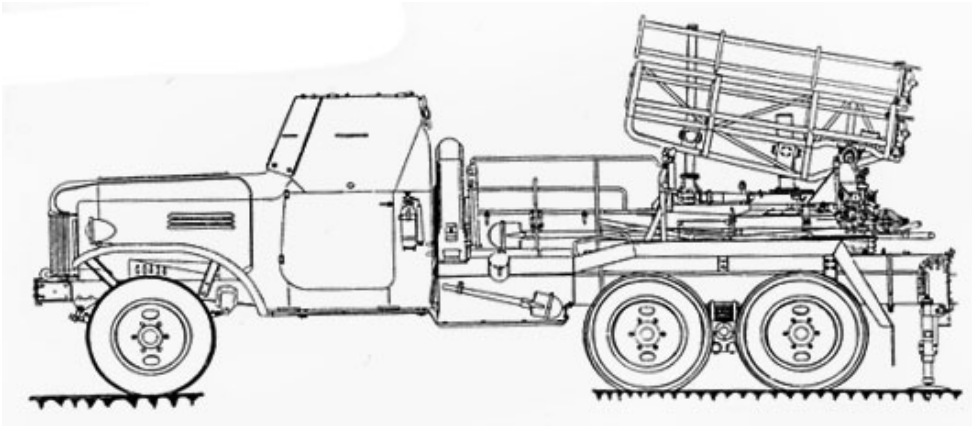
A type	High-explosive fragmentation	Dymovoy	Chemical
Projectile name	M-14-OF	M-14D	M-14
GAU index	OF-949	D-949	?
Year of adoption	1952	1955	1955
Projectile length, mm	1086	1051	1050
Explosive weight, kg	4.2	0.33 + 3.6 kg phosphorus	2D4 OVR-35
Projectile weight with fuse, kg	39.6	40.28	39.6
Fuse type	B-25	B-25	B-25
Powder charge weight of the engine, kg	7.65	7.65	7.65
Muzzle velocity of the projectile, m / s	27-40	27-40	27-40
Projectile speed at the end of the active area, m / s	399-403	399-403	399-403
Firing range, m: maximum minimum	 9800 1000	 10060 1000	 9800 1000

Chapter 2

240-mm M-24 system

In 1955, the BM-24 combat vehicle with M-24F and MS-24 turbojet projectiles was adopted by the Soviet Army. The combat vehicle BM-24 (GAU index - 8U31) was created in the SKV MOP under the leadership of V.P. Barmin.A ZIS-151 all-terrain vehicle was adopted as the chassis of the combat vehicle. (Fig. 124, 125)

Fig. 124. Fighting vehicle BM-24



The BM-24 multiple launch rocket system was intended to suppress and destroy enemy fortifications, strongholds and nodes of resistance; destruction and suppression of artillery and mortar batteries; destruction and suppression of enemy manpower and equipment in concentration areas.
Combat vehicles BM-24 were included in brigades (regiments) of corps subordination. In total, the rifle or mechanized corps had 54 BM-24 combat vehicles.
The BM-24 installation had 12 frame (honeycomb) guides, placed on a swing frame. The frame, in turn, is mounted on a pedestal. Swivel mechanism of worm type. The lifting mechanism is screw type. The lifting and slewing mechanisms are manual. The balancing mechanism is spring-loaded pushing type.
BM-24 was equipped with a 95 hp carburetor engine. from. BM-24 with the calculation, equipped with 12 shells, had a cruising range on the highway up to 600 km. The cockpit and gas tanks had light protection designed to protect them from the action of the gas jet of the projectile.

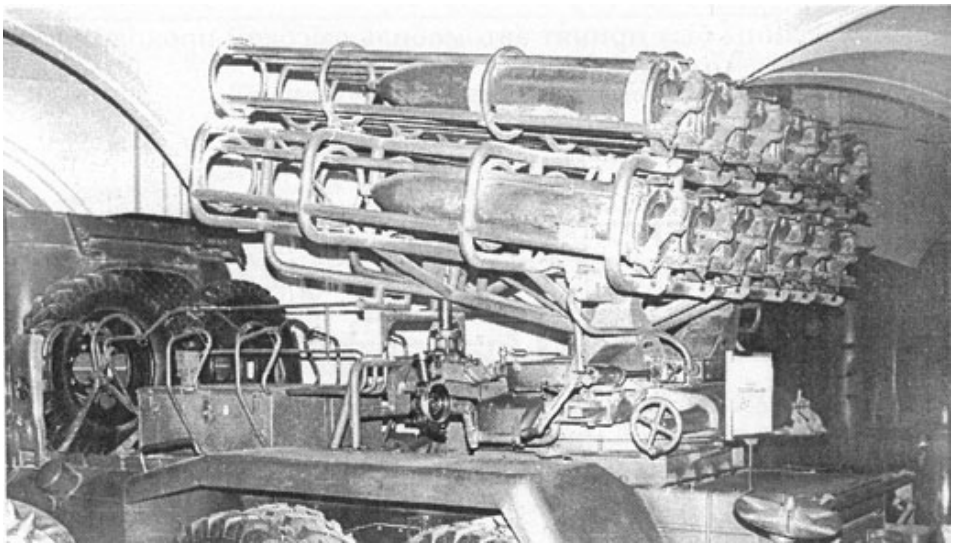
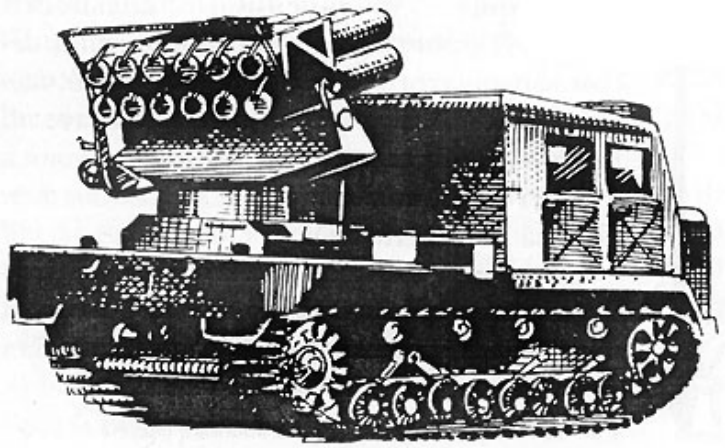


Fig. 125. Combat vehicle BM-24 (artillery unit)

When firing on the ground, two jacks were lowered, located at the rear of the combat vehicle. Jacks are necessary to unload the rear axle springs and ensure the stability of the machine when firing.
The combat vehicle was loaded manually using a special grip and tray. Two numbers of the calculation raised the projectile by gripping, and the third supported the projectile by the nozzle bottom. Then the projectile was placed on a tray and sent to the guide until the projectile went behind the rear stopper.
In addition to the BM-24, a BM-24T combat vehicle was created for 240-mm projectiles on the chassis of the AT-S medium tracked artillery tractor (product 712). The BM-24T combat vehicle entered service with the tank corps of the Soviet Army. (Fig. 126)
Compared to the wheeled combat vehicle, the BM-24T was more expensive, had a lower speed on the highway, and a reduced motor resource. But, having a high cross-country ability, it was able to operate as part of a tank unit in complete off-road conditions.
BM-24T was equipped with a V-54T diesel engine, which developed a power of 275 liters. from. at 1600 rpm. In two tanks, a fuel supply of 420 liters was placed, which made it possible to move on medium ground without refueling for a distance of up to 300 km.
In place of the tractor body, a welded frame was placed on which the artillery part of the combat vehicle was installed. The fundamental difference between the BM-24T and the BM-24 was the replacement of cellular guides with tubular ones. The main advantage of tubular guides in multi-barreled launchers is the exclusion of the possibility of a gas jet from one projectile affecting other projectiles when the projectile moves along the guides. In addition, with the same ballistics, tubular guides are shorter than honeycomb guides.
Twelve 241-mm tubular-type guides were installed on a swivel connected by a ball shoulder strap to a fixed pedestal. The curbstone was attached to the side members of the chassis frame. The lifting mechanism is screw. The handwheel drives are manual.

Fig. 126. Fighting vehicle BM-24T



Initially (in 1955), the BM-24 received M-24F, M-24FUD and MS-23 turbojet projectiles, and in 1962, the MD-24F and MS-24UD turbojet projectiles were adopted. (Fig. 127, XXXIV color insert)
240-mm turbojet projectiles consisted of a head and rocket parts. In the rocket part, a powder charge was placed, consisting of 19 cylindrical single-channel sticks of FSG-2 or KDSI nitroglycerin powder. In the nozzle bottom there were 16 nozzles, the axes of which are inclined to the axis of the projectile at an angle of 15 °. Due to the inclination of the nozzles, a tangential force arose that untwisted the projectile.
The extended-range projectile M-24FUD differed from the M-24F in the lower weight of the explosive in the warhead and the device of the jet engine. In the missile part of the M-24FUD, 7 thick-bore single-channel RSI-12K powder bombs were placed.
The M-24F (M-24FUD) projectile, when firing at an angle of + 45 ° and setting the fuse to a delayed action, formed a funnel with a diameter of 5-6 m (1.5-2.5 m) and a depth of 3-4 m (1.5-2.5 m).

Fig. 127.240-mm high-explosive rocket M-24F

The MS-24 and MS-24UD shells were filled with a toxic substance. The head part of the 3X1 MS-24 projectile was loaded with 19 kg of R-35 substance. The MS-24UD projectile had a long range, but contained less poisonous substance (12 kg).
Fighting vehicle BM-24 (BM-24T), when using high-explosive shells, was able to solve tasks of destroying field fortifications and destroying enemy personnel and equipment in concentration areas. One volley of BM-24 chemical shells could destroy the enemy at once over an area of several hectares.

Combat vehicle data

	BM-24	***BM-24T***
Combat vehicle base	ZIL-151	AT-S
Number of guides	12	12
Length of guides, mm	2000	1400
VN angle, degrees	+ 10 °; + 50 °	+ 10 °; +50
Angle GN, degrees	140 ° *	180 ° *
System length, mm	6930	5970
System width, mm: in combat position	2650	2435
in the stowed position	2320	2435
System height, mm: in the stowed position	2800	3000
in firing position at the maximum elevation angle	3510	?
Artillery unit weight, kg	1420	2870
BM weight without calculation, shells and spare parts, kg	7140	14118
BM imp with crew, shells and spare parts, kg	8910	16100
Performance data		
Full salvo time, s	6-8	6-8
Transition time from the stowed position in combat without loading, min	1.5-2.0	1.5-2.0

Loading time, min	3-4	3-4
The speed of the charged BM on the highway, km / h	55	35
Wading depth, mm	750	1000
Greatest angle of ascent, degrees	28 °	30 °

* In the sector where the cockpit is located, the descent angle is slightly larger.

Table 66

Data from 240 mm turbojet projectiles

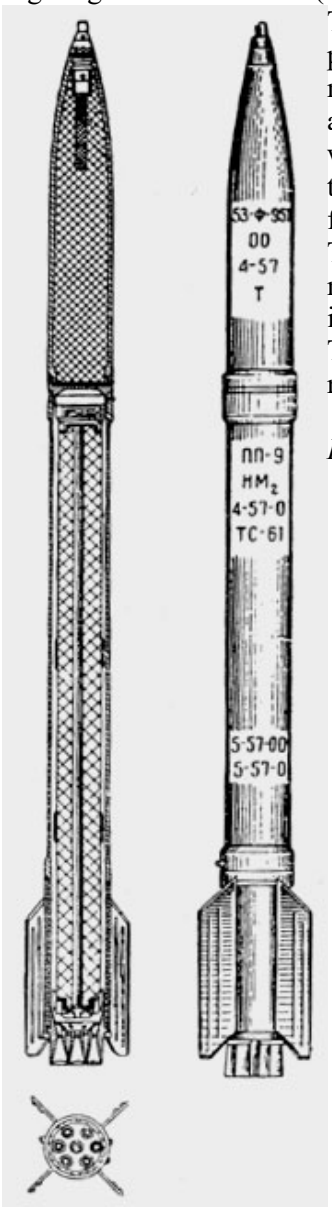
Projectile	M-24F	M-24FOOD	MD-24F	MS-24	MS-24UD
Caliber, mm	240.6	240.6	240.6	240.6	240.6
GAU index	F-961	F-961U	?	?	?
Ballistic index	TS-59	TS-64	?	?	?
Fuse type	B-25M; B-25; B-24	B-25	?	?	?
Projectile length with fuse, mm / clb	1124 / 5.1	1245 / 5.2	1684	1240	1240
Projectile weight, kg	112.25	109.0	155.0	109.0	109.0
Explosive weight, kg	27.4	18.4	19.8	?	?
Powder weight in a rocket engine, kg	16.12	23.96	?	?	?
Engine operation time (from -40 ° to + 50 ° C), s	1-0.5	2.2-0.9	?	?	?
Muzzle velocity of the projectile (from -40 ° to + 50 ° C), m / s	30-45	27-37	?	?	?
Length of the active section of the trajectory, m	90	230-350	?	?	?
The speed of rotation of the projectile at the end of the active section of the trajectory at an elevation angle of 45 °, m / s	280	468.5	?	?	?
Maximum flight range , m	6575	10600	17500	6500	16000

Chapter 3

200-mm BMD-20 system

The BMD-20 multiple launch rocket system was put into service in 1951. The system was developed at SKB MOP under the leadership of V.P. Barmin. The system included a BMD-20 combat vehicle on the ZIL-151 chassis and an MD-20F high-explosive projectile.
MLRS BMD-20 was intended to suppress and destroy fortifications, strong points and nodes of enemy resistance; destruction and suppression of artillery and mortar batteries; destruction and suppression of enemy manpower and equipment in concentration areas.
Stabilization of the MD-20F projectile in flight was provided by a four-wing stabilizer. The eccentricity of the rocket engine thrust was compensated by the rotation of the projectile around its axis due to the thrust of the peripheral nozzles of the engine.

The MD-20F projectile was equipped with a VD-20 head fuse. The fuse had three settings: "O" - for instant action, "M" - for small deceleration and "B" - for large deceleration. (Fig. 128)
The propellant charge was a single-channel cylindrical large-capacity stick made of nitroglycol powder. The nozzle block had six peripheral nozzles and one central nozzle. The axes of the peripheral nozzles are inclined at an angle of 5 ° to the plane passing through the central axis of the projectile, which provided additional rotation of the projectile in the active section of the trajectory. The central nozzle is located along the axis of the projectile. The rotation of the projectile when moving along the guide was provided by the driving pin. In addition, he kept the projectile in a charged state on the rail.
Fighting vehicle BMD-20 (8UZZ) with four rails is mounted on the chassis of a ZIL-151 vehicle.



The guides of the BMD-20 combat vehicle were a welded structure consisting of a frame, pipes, clips, a leading and tubular rods. The lead and tubular rods are helical. The projectile moved along the leading and tubular rods when fired. In this case, the projectile pin moved along the groove of the driving rod. The guides are installed on the truss. The truss was a spatial welded structure. It is installed in the bearings of the swing frame brackets and, together with the guides, forms the swinging part of the combat vehicle. A loading device is installed on the farm. (Fig. 129, 130)
The pivot frame with a truss installed on it, guides, pivoting and lifting and balancing mechanisms and sighting devices was a rotating part of the combat vehicle. The swivel frame is installed on a stretcher and, when rotating, moved with its plates along the stretcher plates.
The subframe served as the basis for the artillery unit of the combat vehicle and was a welded rectangular frame fixed to the side members of the vehicle chassis.

Fig. 128.200-mm high-explosive rocket projectile MD-20F

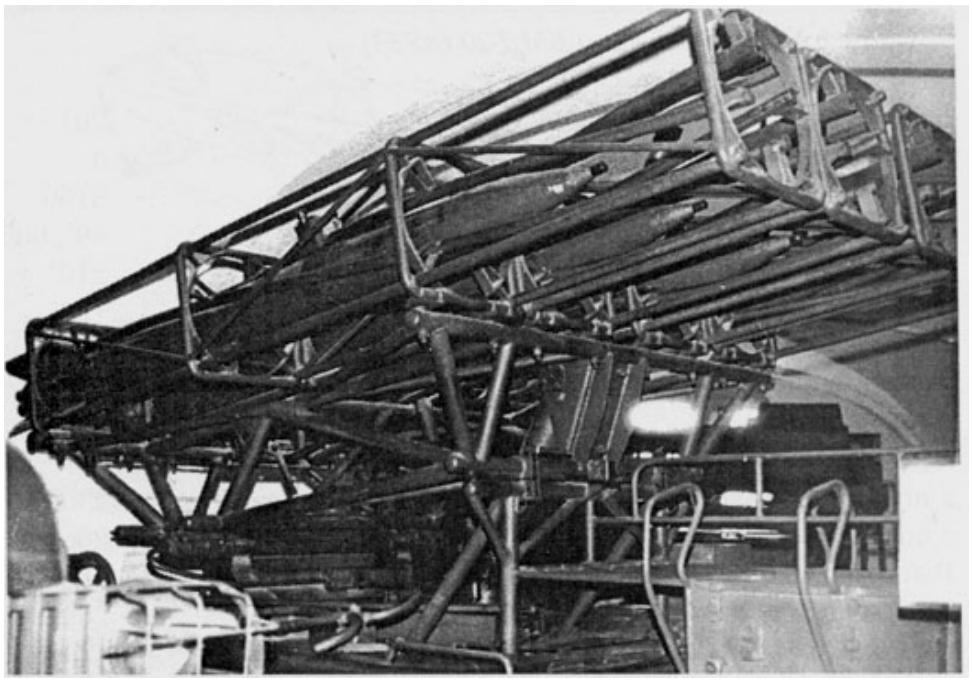


Fig. 129. Artillery unit BMD-20

Rotary screw type. The lifting and balancing mechanism consisted of a screw lifting mechanism and a push-type spring balancing mechanism.
When firing, the combat vehicle relied on two rear jacks.
Loading was done manually. Five numbers of the calculation raised one projectile and put it on a special tray, then put a rammer on the projectile nozzles and sent the projectile into the guide so that the leading pin went behind the back stop. (Fig. 131)

Combat vehicle data BMD-20 (8U33)

Design data	
Caliber of guides, mm	201
Number of guides	four
Guide length, mm	3160
Angle of vertical guidance, degrees	+ 9 °; 60 °

Horizontal guidance angle, degrees	± 10 °
Loading angle, hail	+ 20 °
Combat vehicle length in stowed position, mm:	
without winch	7210
with winch	7540
Combat vehicle width, mm:	
in the stowed position	2300
in combat position	2660
Combat vehicle height, mm:	
in the stowed position	2850
at maximum elevation	4250
Weight summary, kg	
Artillery unit weight	2400
Combat vehicle weight, kg:	
without shells and calculation	7455
with shells and crew	8700
Performance data	
The minimum time for a full salvo, s	6
Time of transition from traveling to combat position	
(without loading), min	2
Loading time, min	4-5
Effort on the handle, kg:	
lifting and balancing mechanism drive	to 10
swing mechanism	to 10
Elevation angle change in one revolution	
flywheel, hail	15'
Changing the angle of rotation per one turn of the handle, degrees	27 '
Maximum travel speed charged	
combat vehicle, km / h	up to 60
Maximum pulling force of the winch, kg	4500
The depth of the ford overcome by the charged	
combat vehicle, mm	750
The greatest rise overcome by a charged	
combat vehicle	
on hard and dry ground	28 °
Range on the highway, km	up to 600

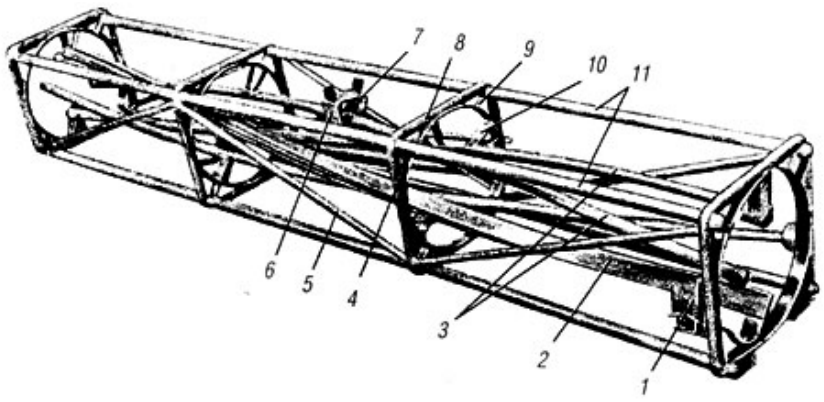


Fig. 130. Guide. BMD-20
1 - lock; 2 - leading rod.
3 - tubular rod;
4 - clip;
5 - brace; 6 - contact;
7 - adapter box;
8 - frame; 9 - brace; 10 - foot; 11 - pipe

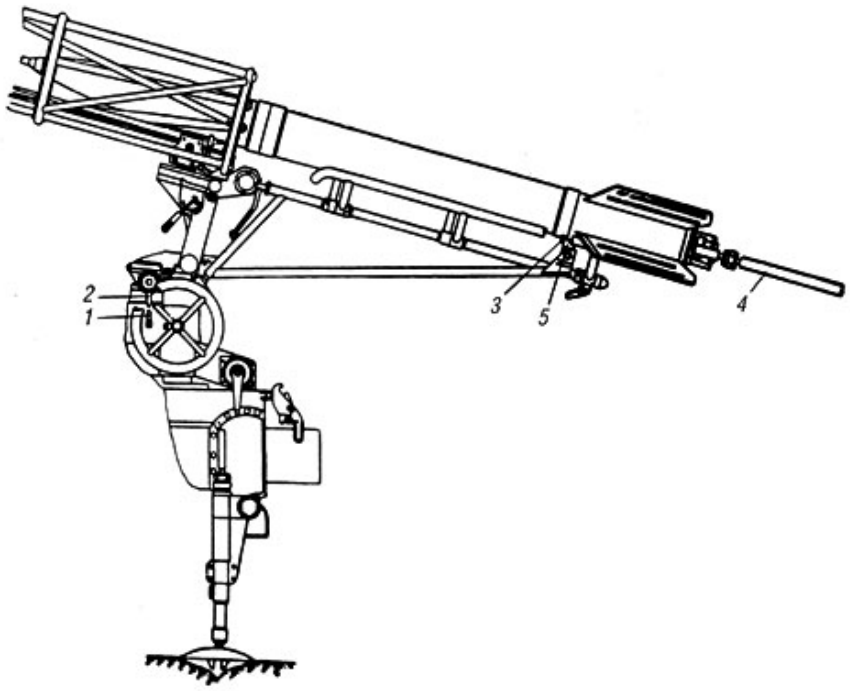


Fig. 131. Loading combat vehicle BMD-20
1 - arrow;
2 - arrow;
3 - projectile pin;
4 - rammer;
5 - stop

Projectile data MD-20-F

Caliber, mm	200
Projectile index	F-951
Ballistic index	TS-61
Projectile length with fuse, mm	3040
Final loaded projectile weight, kg	194
Explosive weight, kg	30.08
Powder charge weight, kg	52.1
Engine operation time, s	5.6-3
Length of the active section of the trajectory, m	1275-825
Maximum projectile speed, m / s	535-590
Descent speed of the projectile from the guide, m / s	22-34
Firing range under normal conditions, m	18750
Closure weight, kg	90
Funnel diameter at average soil density, m	5.5-6.0
Funnel depth	2.9-3.1

Chapter 4

122-mm system "Grad"

The Grad system was designed to replace the M-14. Its 122-mm high-explosive fragmentation projectile M-21-OF (9M22) was intended to destroy and suppress enemy manpower and military equipment in concentration areas; to destroy and suppress artillery and mortar batteries; to destroy fortifications, strongholds and nodes of enemy resistance. The new projectile was stabilized both by the tail unit and by rotation. More precisely, the rotary motion, since it was extremely small - tens of revolutions per second, did not create a sufficient gyroscopic effect, but it compensated for the deviation of the engine thrust. Thus, the most important reason for the dispersion of shells was excluded. In order to use the tubular guides, the fenders were made folding.

On May 30, 1960, the Council of Ministers issued a decree No. 578-236 on the start of work on the "Grad field divisional rocket system".
The main executor of the system was NII-147 * SKB-203 made the launcher, NII-6 - solid propellant charges, GSKB-47 - equipment of warheads.
Self-propelled unit BM-21 of the Grad system consists of an artillery unit and a chassis of the Ural-375D vehicle. The artillery unit is used to aim projectiles at the target and launch their jet engine. The artillery unit consists of 40 tubular slime guides, forming a so-called package: four rows of 10 pipes each. The tube is designed to direct the flight of the projectile, as well as to transport it. The caliber of the pipe is 122.4 mm, the length is 3 m. The guidance of the pipe package in the vertical and horizontal planes is carried out using an electric drive and manually.

* NII-147 was created in 1945. In March 1966, NII-147 was renamed into the Tula State Research Institute of Precision Engineering, and in May 1977 - into the Scientific and Production Association “Splav”. The last name - State Research and Production Association "Splav" - was assigned in 1992.

The lifting mechanism is located in the center of the base, its main gear engages with the toothed sector of the cradle. When guided by an electric drive or manually, the main gear rotates the toothed sector, and elevation angles are given to the swinging part of the combat vehicle.
The swing mechanism is located on the left side of the base. Its main gear meshes with the stationary inner ring of the shoulder strap.
When the combat vehicle is guided by an electric drive or manually, the main gear is rolled over a fixed inner ring and thereby rotates the rotary part of the combat vehicle.
The balancing mechanism serves to partially balance the swinging part of the combat vehicle and is located in the cradle. It consists of two identical torsion bars - packages of steel plates working in torsion. One end of the torsion bar is embedded in the cradle, and the other end is connected to the base by a system of levers.
Sights consist of a mechanical sight, a panorama of the PG-1M and a K-1 collimator.

Data of the BM-21 combat vehicle on the Ural-375D chassis

Number of pipes	40
Full salvo time, s	20
VN angle, degrees	0 °; + 55 °
Angle GN, degrees: to the right of the chassis axis	70 °
to the left of the chassis axis	102 °
Cabin bypass angle, degrees	± 34 °
The smallest elevation angle of the package in the cockpit area	11 °
GN speed by electric drive, deg / s	up to 7
HV speed by electric drive, deg / s	up to 5
Manual drive speed GN	6 min (per flywheel revolution)
HV speed by hand drive	4 min (per flywheel revolution)
Length in stowed position, mm	7350
Width, mm: in the stowed position	2400
in combat position	3010
Height in stowed position, mm	3090
Height at maximum angle elevation, mm	4350
Height in the position of the swinging part 0 °, mm	2680
Combat vehicle weight without shells and calculation, kg	no more than 10 870
Efforts on the handle of manual drives guidance, kg	no more than 8
Maximum travel speed charged combat vehicle on solid roads coverage, km / h	up to 75
Fuel consumption per 100 km on the highway at a speed of 40 km / h, l	46
Fuel capacity, l: main tank	300
additional	60
Engine power at 3200 rpm, hp from.	180
Maximum ford depth, taking into account the wave,	

overcome by a combat vehicle, mm	1500

Initially, the only round at the Grad was the 9M22 (M-21-OF) high-explosive fragmentation projectile with an MRV fuse (9E210). The length of the projectile is 2870 mm, and the total weight is 66 kg. The warhead weighing 18.4 kg contained 6.4 kg of explosives. In terms of fragmentation, the 9M22 projectile was twice as effective as the M-14-OF projectile, and 1.7 times more effective in high-explosive. (Fig. XXXVI color insert)
The rocket powder charge consists of two cylindrical checkers - head and tail with a total weight of 20.45 kg.
The 9M22 projectile was equipped with long-range cocked head fuses MRV and MRV-U. The fuses have three settings: for instant action, for small deceleration and for large deceleration.
The 9M22 projectile has a TC-74 ballistic index. The maximum firing range of the 9M22 is 20.4 km, and the minimum range actually exceeds 5 km. Theoretically, you can shoot at 1.5 km, but the dispersion of shells is many hundreds of meters. At the maximum range, the range dispersion was 1/130, and the lateral dispersion was 1/200.
The speed of the projectile descent from the guides is 50 m / s, and the maximum speed is 715 m / s.
To improve accuracy when firing at a distance of 12 to 15.9 km, a small brake ring is put on the 9M22 projectile, and when firing up to 12 km - a large brake ring.
On the basis of the 9M22 projectile (while retaining its engine and ballistics) in 1963, a special 9M23 Leica chemical fragmentation projectile was created. Work on it was started at NII-147 under the contract dated August 11, 1961. This projectile has the same weight and size characteristics with the 9M22 projectile and the same ballistics.
"Leica" is equipped with 3.11 kg of the chemical R-35 or 2.83 kg of the chemical R-33. In addition, the warhead of the projectile contains 1.8 kg of explosives when loaded with R-35 or 1.39 kg when loaded with R-33. The "Leica" projectile has a 1.5 times larger area of destruction than chemical 140-mm projectiles of the M-14 type.
The 9M23 projectile is equipped with an MRV (9E210) mechanical fuse and a 9E310 radar fuse, which fires at a predetermined height from the surface (1.6-30 m). An air explosion significantly increases the area affected by shrapnel and a toxic substance. "Leica" gives 760 "useful" fragments with an average weight of 14.7 g. The firing range with a radar fuse has decreased slightly (from 20.4 to 18.8 km).
Two experimental installations "Grad" successfully passed factory tests at the end of 1961. On December 31, 1961, the developers presented GRAU with 500 shells and two Grad launchers. On March 1, 1962, in the Leningrad Military District, state field trials of the Grad complex began, 663 launches and 10 thousand kilometers were planned. However, the 2B5 installation passed only 3380 km, after which the left side member of the frame chassis broke, and the tests were suspended. After that, new chassis were submitted. Soon, on the new chassis, the rear and middle axles were deflected and the propeller shaft was bent from collision with the balancer axle.
Nevertheless, the "Grad" system was adopted by a decree of the Council of Ministers of March 28, 1963. Delivery of serial samples of "Grad" began in 1964.
Serial production of BM-21 units was carried out at Plant No. 172 in Perm. In 1970, 646 combat vehicles were manufactured. In 1971 - 497 combat vehicles, of which 124 were exported. In the first half of 1972, 255 combat vehicles were manufactured, of which 60 were exported. By 1995, over two thousand BM-21 combat vehicles were delivered to 50 countries of the world.
Serial production of 9M22 rockets was started at plant No. 176 of the Prioksky Economic Council. The 1964 plan provided for the production of 10,000 shells, including 5,000 in the first half of the year. Initially, the production of shells was significantly behind schedule. In the first quarter of 1964, only 642 missile units and 350 warheads were manufactured.
In the Soviet Army, the artillery regiments of rifle divisions had two divisions: one with Grad rocket launchers, the other with self-propelled artillery mounts.
Military exercises and local conflicts confirmed the superior qualities of the Grad system. The Grad complex received its first baptism of fire in March 1969 near Damansky Island during the conflict between the USSR and the PRC. Let us remind the reader that the island was occupied by Chinese troops, and an attempt to knock them out with the help of tanks and armored personnel carriers ended in failure. Moreover, a "secret" model of the T-62 tank was hit and captured by the Chinese. After the massive use of Grad installations, firing high-explosive shells, the island was completely torn apart, and the Chinese forces were destroyed. Actually, the volleys of the Grad ended the conflict on this island.
In the 70s-90s, the Grad complex was used in almost all local conflicts in the world, in various climatic conditions, including extreme ones.
The tactics of using the Grad were different. For example, in 1975-1976 in Angola the war was of a maneuverable nature. There was no continuous front. Both government troops and Cuban "volunteers" and their opponents used only detachment-column methods of movement. No major encirclement operations were carried out. Usually, oncoming battles of hostile columns moving towards each other began. Then the method of "pushing out" the opponents and their pursuit was applied. As you know, the range dispersion of rockets is many times greater than the lateral dispersion, that is, the places where the projectiles fall form a highly elongated ellipse. Therefore, the elongated column of enemy troops in the oncoming battles in Angola was an ideal target.
In Afghanistan, on the contrary, shooting was most often carried out in areas, including settlements. There our artillerymen first began to use fire from the Grad installations at low elevation angles and direct fire.

Palestinian guerrillas in Lebanon used the tactics of nomadic multiple launch rocket launchers. Only one BM-21 installation hit the Israeli troops, which then immediately changed its position.
In a number of conflicts, "Grad" was used by both sides. So, the USSR put a battery of four BM-21s in Somalia. But the main batch of BM-21s, sent by sea, was redirected and unloaded in Ethiopia, and later took part in the hostilities against Somalia.
In 1992, Russian troops in Chechnya left 18 BM-21 installations and 1,000 missiles to Dudayev. Yes that "Grad", Yeltsin's generals managed to leave two launchers "Luna" in Chechnya, it's good - without missiles with special charges. During the 1994-1995 war, both sides in Chechnya made extensive use of the Grad system. On February 9, 1995, the Chief of the General Staff of the Ministry of Defense, General of the Army MP Kolesnikov, announced that from December 11 to February 8, 16 Grad installations were destroyed along with other Chechen equipment. One BM-21 installation was used during an unsuccessful assault on the village of Pervomayskoye, captured by terrorists. It is difficult to draw any conclusions on the effectiveness of the Grad in the Chechen war, since the war was waged by the Russian side in an extremely stupid way. For example, there is a known case when a Chechen BM-21 deployed into a combat position was discovered by a Mi-24 helicopter,
The Grad complex was used even more intensively during the second Chechen war.
Long before these events, attempts began to modernize the "Grad" both in terms of chassis and ammunition. Since the dimensions and weight of the standard Grad installations (BM-21) were comparatively large, in the USSR an easier BM-21V installation was created for the airborne troops on the chassis of the GAZ-66B car, in which the number of 122-mm pipes was reduced from 40 to 12. In 1975, in Czechoslovakia, the RM-70 installation was created by imposing the Grada artillery unit on the Tatra-813 chassis. In the 70s and 80s in the Arab countries, the artillery unit of the "Grad", having reduced the number of pipes to 30, was installed on various chassis, from Soviet ZIL-131 vehicles to Japanese ISUZU vehicles.
In the 1980s, a new Prima complex was created on the basis of the Grad in the USSR. The number of 122-mm pipes was increased to 50. The Ural-4320 was taken as a chassis. The time for a full salvo of Prima was 30 seconds. Unfortunately, due to financial difficulties in the early 90s, "Prima" did not go into mass production.

Combat vehicle data

System name	***"Grad"***	***"Grad-V"***	***"Prima"***
Combat vehicle index BM-21	BM-21	BM-21V	9A51
Automotive chassis	Ural-375D	GAZ-66B	Ural-4320
Projectile caliber, mm	122	122	122
Number of guides	40	12	50
System weight in firing position, kg	13 700	about 6000	13 900
Engine power, hp from.	180	115	210
Road speed, km / h	75	85	85

During the Vietnam War, at the request of the government of the DRV, a portable complex "Grad-P", or, as it was then called, "Partizan", was created in the USSR. On the 9P132 portable launcher, weighing only 35 kg, one tubular guide was installed. Calculation of the installation of 2 people. The ammunition load of the installation included several shells, including the 9M22M. (Fig. XXXVII color insert)
The 9M22M high-explosive fragmentation projectile with a 9E231 fuse was created in 1962-1964 on the basis of the 9M projectile and was structurally little different from it. The 9M22M shell was originally called Grad-1. The 9M22M projectile has a TC-78 ballistic index. The maximum tabular range is 11 km, the minimum is 2 km. Firing 9M22M shells at a distance of up to 3 km due to significant dispersion of shells was carried out in exceptional cases and only in the absence of its troops in the direction of fire. To improve the accuracy of fire at distances up to 7 km, a brake ring with a diameter of 122 mm was put on the projectile.
Several hundred Grad-P units were delivered to Vietnam, where they found wide application. The Grad-P was especially effective at hitting American airfields in South Vietnam.
The manufacture of launchers 9P132 was carried out at the Kovrov Mechanical Plant. So, in 1970, 406 Grad-P launchers were manufactured, of which 400 were exported (to Vietnam). Data on 1971 was not found, and in the first half of 1972 155 pieces were manufactured, all were exported.

Modernization of missiles and launchers of the "Grad" complex

In the 70s-90s, fundamentally new types of ammunition were created for the Grad. Among them:
- a rocket for setting anti-personnel minefields, weighing 56.4 kg. Its warhead weighing 21.6 kg contains 5 POM-2 anti-personnel fragmentation mines. Each mine weighing 1.7 kg contains 0.13 kg of explosive. The maximum firing range of shells with antipersonnel mines is 13.4 km. A salvo of 20 shells can reliably mine one kilometer of the front. To prevent

mines from being dangerous for their own troops, they have a programmable device for self-destruction of mines in the interval from 4 to 100 hours from the moment of setting;
- a rocket for setting anti-tank minefields, ensuring the defeat of armored vehicles from below under the entire projection with a shaped charge with high armor penetration. The projectile weighs 57.7 kg, the warhead weighing 22.8 kg contains three mines. The weight of the mine is 5 kg, the weight of the shaped charge is 1.85 kg. The firing range is 13.4 km. To mine one kilometer of the front, 90 shells are required. Mine self-destruction time from 16 to 24 hours;
- a rocket smoke projectile weighing 66 kg with a firing range of 20.2 km. The projectile contains 5 smoke elements, each loaded with 0.8 kg of red phosphorus. A salvo of 10 missiles forms a continuous curtain along the front of 1000 m and along a depth of 800 m. The cloud lasts an average of 5.3 minutes;
- a set of rockets for creating radio interference in the range from 1.5 to 120 MHz with a firing range of up to 18.3 km;
- a rocket illuminating projectile illuminating a circle with a diameter of 1000 m on the ground from a height of 450-500 m, illumination of 2 lux for 90 seconds.

Currently, the designers of the Splav State Scientific and Production Enterprise are working on the creation of new shells for the Grad system. The first of them is a projectile with a firing range of up to 35 km and a high-powered warhead. In addition to a composite fuel engine, it uses a high-explosive warhead with a block of ready-made fragments and a high-power explosive load. The effectiveness of hitting the target with this projectile will increase on average twice as compared to the standard one.

The second projectile has a detachable high-explosive fragmentation warhead and a firing range of 33 km. (Fig. 132, XXXVIII color insert) It is equipped with a remote fuse, after which the head part is separated from the engine. Then the warhead is decelerated by the parachute system and rushes to the ground along a trajectory close to vertical. Depending on the presetting of the remote fuse, the explosion can occur above the ground at a height of 0 to 30 m.

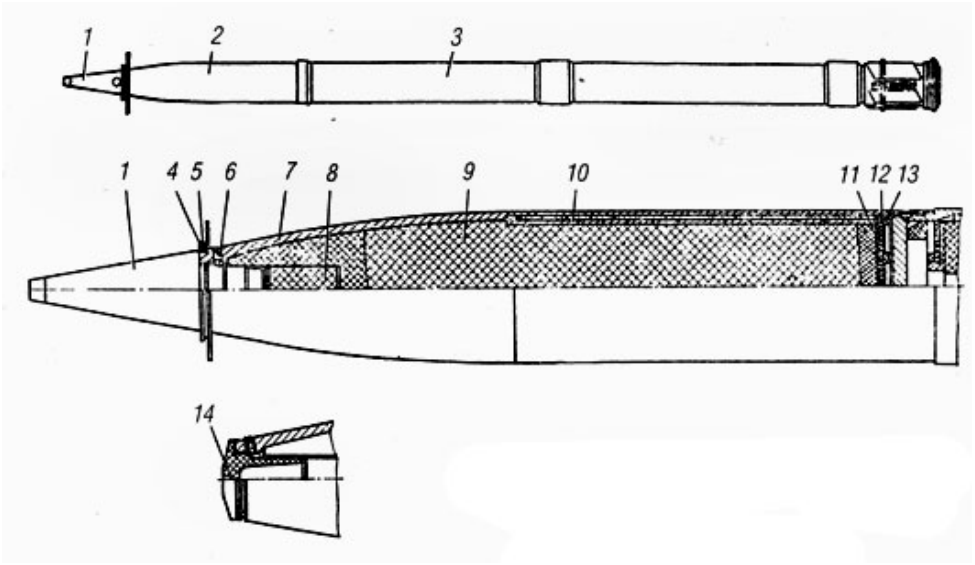


Fig. 132.122-mm round of the Grad system
1 - fuse MRV-U or MRV;
2 - head part;
3 - missile part;
4 - large (small) brake ring;
5 - spring; 6 - screw;
7 - body; 8 - detonator checker;
9 - explosive, charge; 10 - bushing;
11 - gasket; 12 - plate;
13 - plug; 14 - cork

The third projectile has a detachable warhead equipped with two homing (adjustable) combat elements designed to destroy armored vehicles. At a given height, combat elements are fired from the missile warhead. After shooting, the combat element's parachute opens and it slowly descends. Infrared sensors located on the element detect an enemy tank, and an armor-piercing spherical core is fired from the element into the roof of the tank. (Fig. XXXIX color insert)

Work continues on the modernization of the BM-21 combat vehicle. The most important direction of its modernization is the replacement of a package of guide pipes made of metal with two monoblocs of disposable transport and launch containers (TPK) made of polymer composite materials. They are installed on a combat vehicle using a special additional adapter frame. (Fig. XLI color insert)

TPK provide transportation and launch of rockets, as well as their storage both on combat vehicles and in arsenals. The reloading of combat vehicles is carried out by replacing containers with the help of lifting equipment, and their electrical interface - through a special electrical connector. The modernization of the BM-21 combat vehicle can be carried out under the conditions of the customer operating the combat vehicle. The weight of one TPK without shells is 370 kg, with shells 1770 kg. The charging time is reduced to 5 minutes.

Currently, combat vehicles are manufactured by JSC Motovilikhinskiye Zavody on the chassis of the Ural-4320 vehicle. In the modernized version, the automated control system provides autonomous topographic reference and orientation of the combat vehicle on the ground with display on an electronic map; automated calculation of firing settings; aimless guidance of the guide package without leaving the crew from the cockpit; data entry into the missile fuse. The weight of the BM-21 combat vehicle has increased to 14 tons. The calculation remained unchanged - 3 people.

In 1976, the Grad-1 system was adopted by the Soviet Army. It consisted of: 9P138 combat vehicle, 9F28F 122-mm rocket projectile and 9T450 transport vehicle. The Grad-1 complex was developed at the Splav State Scientific and Production Enterprise. The 9P138 combat vehicle was created on the chassis of the ZIL-131 vehicle, its artillery unit has 36 tubular guides. Volley time - 18 seconds, calculation - 3 people. The weight of the 9P138 combat vehicle with ammunition and calculation is 10,425 kg. (Fig. XL color insert)

The 9F28F rocket weighs 56.5 kg, of which 21 kg is for the warhead, and 14.2 kg for propellant. The firing range is from 1.5 to 15 km. When shooting at the maximum distance, the range deviation is 60 m, and the lateral deviation is 135 m.

The 9T450 transport vehicle was created on the same chassis (from the ZIL-131). She carries 54 shells.

An artillery unit from a 9P138 combat vehicle with 36 guides was installed on a tracked chassis from a 122-mm self-propelled howitzer 2S1 "Gvozdika". However, she apparently did not go into the series.

In the 80s, the Grad State Scientific and Production Enterprise "Splav" was taught to fight ... against submarine saboteurs (combat swimmers) and midget submarines. To protect the entrances to naval bases and guard the maritime border on the basis of the Grad complex, the Dam complex was created, which included the BM-21 PD combat vehicle, the 95TM transport vehicle and the PRS-60 rocket. This projectile, thanks to its cup-shaped tip, provides ricochet-free firing over the entire range of ranges from 300 m to 5 km. The PRS-60 projectile contains 20 kg of a strong explosive and is detonated, depending on the installation of the fuse, at a depth of 3 to 200 m.

It is no exaggeration to say that now the Grad is the most effective multiple launch rocket system of its caliber (100-152 mm).

Chapter 5

Hurricane multiple launch rocket system

The development of a long-range 220-mm multiple launch rocket system was started at the end of 1968. It was originally called "Grad-3". Two variants of the combat vehicle were considered: on the chassis of the ZIL-135LM vehicle with 20 tubular guides and on the chassis of the MT-S tracked tractor ("object 123") with 24 tubular guides. On both launchers, the vertical guidance angle is 0 °; + 55 °, horizontal guidance angle 60 °. The tactical and technical requirements for the system provided for a single firing table and the same warhead weight (80 kg) for all types of shells.

Full-scale work on the 220-mm multiple launch rocket system "Uragan" was started by the decision of the Ministry of Defense and Defense on March 31, 1969 at the Perm Gun Plant (former No. 172). The first prototype of the Uragan MLRS was manufactured in February 1972, and in 1976 the Uragan MLRS was put into service. (Fig. 133, 134, 135 XLII, XLIII color insert)

The ZIL-135LM chassis was used as a base for the combat and transport-loading vehicle. Due to the fact that the serial production of the chassis was carried out at the Bryansk plant, it was named BAZ-135LM. The combat vehicle has 16 tubular guides. The number of shells carried on the transport-loading vehicle is 16 pieces.

The Hurricane's ammunition includes missiles with 9M27F monoblock high-explosive warheads, 9M27K cluster warheads with 30 high-explosive fragmentation elements, 9M27K2 with 24 anti-tank mines, 9M27KZ with 312 anti-personnel mines. Incendiary warheads can contain 4 incendiary elements. In addition, according to the Western press, there are warheads with a volume-detonating mixture and toxic substances. (Fig. XLIV color insert)

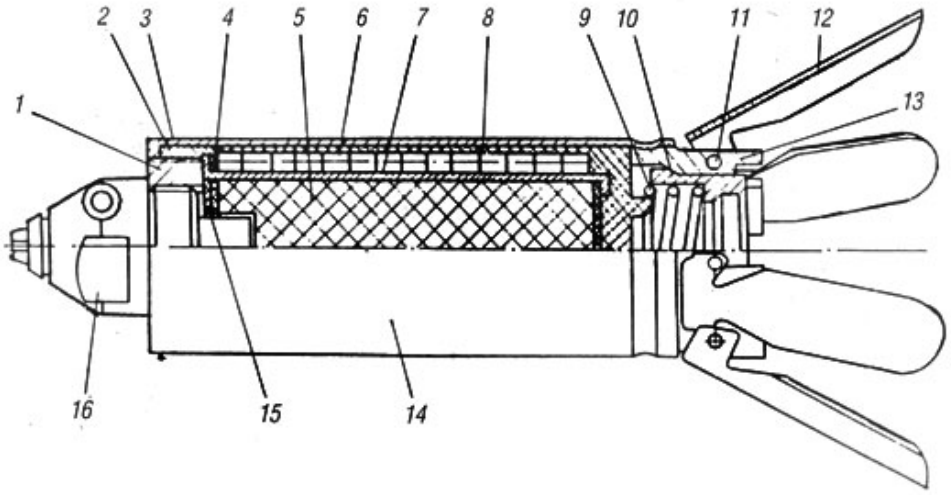


Fig. 133. Anti-personnel cassette element for "Hurricane"
1 - transition ring; 2 - ring
threaded; 3 - casing; 4 - gasket;
5 - explosive charge 9X37;
6 - rollers; 7 - glass;
8 - polyethylene; 9 - spring;
10 - pusher; 11 - axis;
12 - blade; 13 - clip;
14 - combat element;
15 - gaskets;
16 - fuse 9E246M or 9E246

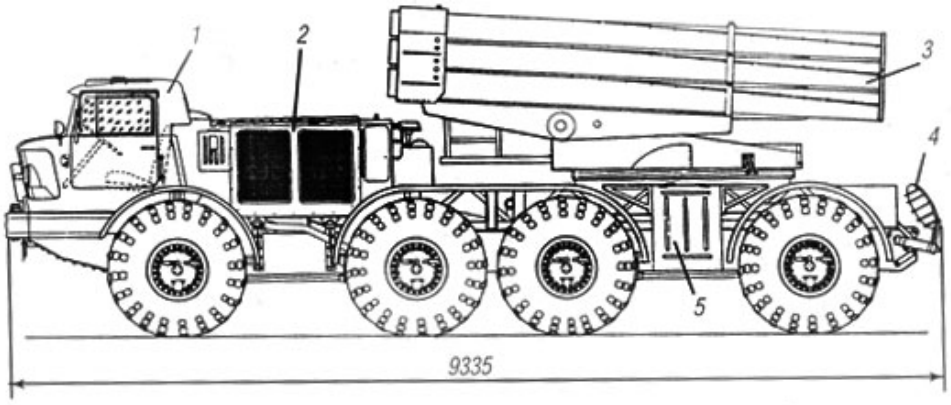


Fig. 134. Fighting vehicle 9P140:
1 - cockpit; 2 - engine compartment;
3 - a package of trunks; 4 - support jack;
5 - box with equipment; 6 - headlamp with blackout attachment;
7 - stairs

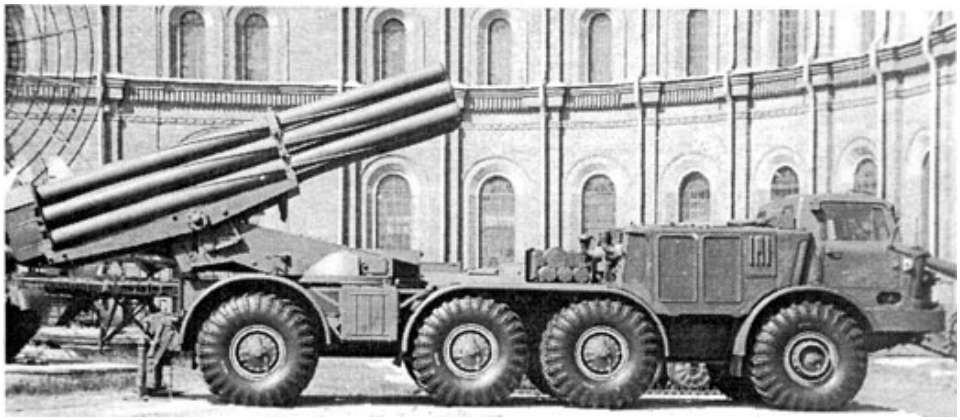


Fig. 135. MLRS "Uragan"

When firing a 9M27K projectile at a given point of the trajectory, a remote 120-second 9E245 tube was triggered, which ignited a special charge. From the pressure of the charge gases, the fuse of 246 combat elements 9N210 was cocked, the fairing was dropped and the combat elements were scattered. The weight of the 9N210 combat element is 1.85 kg. The element contained 300 g of explosive.

In the 9P140 combat vehicle of the Uragan multiple launch rocket system, the guides are located on the cradle in three rows and make up a package that is attached to the cradle with ribbons, dowels and wedges.
The cradle is used to install a package of guides on it and connect it to the upper machine with two semiaxes, around which it rotates (swings when hovering along the elevation angle). The cradle with all assemblies and parts mounted on it constitutes the swinging part of the installation.
The vertical and horizontal guidance mechanisms have electric drives. The balancing mechanism serves to partially balance the swinging part; it is located on the upper machine. The mechanism consists of two identical torsion bars.
Guidance of the vehicle can be done only after bringing it into a combat position. For this, two jacks are reclined in the rear of the combat vehicle. When aiming a combat vehicle with an electric drive, its continuous operation is allowed no more than 5 minutes. The drive can be turned on again only after a 10-minute break.
The 9P140 combat vehicle has a R-123M radio station, which is installed on the 135LM chassis bracket at the vehicle's right door.
Combat crew 9P140 consists of four people:
commander - number one;
gunner - number two;
driver-mechanic - number three;
loader - the fourth number.
The time for transferring a combat vehicle from a traveling position to a combat position in the presence of a firing position prepared in topogeodetic respect and calculated firing settings is no more than 3 minutes; with an unprepared firing position - at least 12 minutes.
It is forbidden to fire from a combat vehicle with a ground wind of more than 20 m / s.
The combat vehicle can be transported over any distance by rail or air (An-22 and Il-7b aircraft).
The complex includes the 9T452 transport and loading vehicle, also created on the ZIL-135LM chassis. The transport-loading vehicle carries 16 missiles. The reload time of the combat vehicle is 15 minutes.
MLRS "Uragan" were successfully used during the Afghan war and both Chechen campaigns. The structure and composition of the units equipped with the Uragan MLRS have not yet been published in the open press, with the exception of a note in the Den newspaper, where it was said that on the eve of the conflict in Transnistria, Yeltsin presented Moldova with the 803rd Uragan MLRS regiment ", Which included 28 launchers 9P140.
The analogue of "Hurricane" is produced only in the USA. It is a 230mm MLRS multiple launch rocket system with 12-tube guides and a range of 30-40 km. MLRS MLRS was put into service in 1981, and in 1983 began to enter the army.

Data MLRS "Uragan"

System index	9K57
Combat vehicle index	9P140
Combat vehicle chassis	ZIL-135LM
Caliber, mm	220
Number of pipes	16
Maximum elevation angle, degrees	55 °
Horizontal angle of fire, degrees	60 °
The smallest elevation angle of the pipe package	
in the cab bypass zone, hail	five
Maximum guidance speeds	
electric drive, deg / s:	
elevation angle	not less than 3
in azimuth	not less than 3
Swing angle manual drive 10 turns	
flywheel, min:	
elevation angle	46
in azimuth	31
Length, mm:	
in the stowed position	9630
in combat position	10830
Width, mm:	
in the stowed position	2800
in combat position	3040
in firing position (at maximum	
turning the guides)	5340
Height, mm:	
in the stowed position	3225

at maximum elevation	5240
Weight of a charged combat vehicle with calculation, kg	20200
Combat vehicle weight without shells and crew, kg	15100
Calculation, people	four
Pipe weight, kg	87.2
Effort on the handle of manual guidance drives, kg, no more	no more than 10
Maximum length of the remote coil cable, m	60
engine's type	ZIL-175Ya
Engine power, hp from.	2x180
Time of a full salvo at a constant rate, s	8
Time of a full volley with a variable rate, s	20
Missile data	
Rocket length, mm	4832/5178 *
Rocket weight, kg	280.4 / 271 *
Head part weight, kg	99 / 89.5 *
The number of high-explosive fragmentation elements in a cluster projectile	thirty

* High-explosive 9M27F / cassette 9M27K.

Chapter 6

Heavy Flamethrower System TOS-1 "Buratino"

Heavy flamethrower system TOS-1 "Buratino" is a 30-barreled multiple launch rocket system. The launcher is mounted on the chassis of the T-72 tank. It consists of a chassis, a turntable with a rocking part of the launcher, power tracking drives and a fire control system. (Fig. XLV color insert)
The rocking part of the launcher has 30 guide tubes of 220 mm caliber for unguided rockets, installed in a common housing with a cradle; through the axle of the pins, it is connected to the arms of the turntable The aiming of the launcher at the target in the horizontal and vertical planes is performed by power tracking drives.
The fire control system consists of a sight, a quantum rangefinder, a ballistic computer and a roll sensor.
An unguided missile (URS) consists of a warhead with a filler and a fuse and a solid propellant rocket.
The transport and loading vehicle is designed to transport the NURS, load and unload the launcher. The transport-loading vehicle is assembled on the chassis of an off-road truck and has a loading and unloading device.
Launcher weight 42 tons. The maximum firing range is 3500 m, the minimum is 500 m.
The first samples of the "Buratino" installation were tested in Afghanistan. In the fall of 1999 - in the winter of 2000, "Buratino" was successfully used in Chechnya, including during the storming of Grozny.

Chapter 7

Multiple launch rocket system "Smerch"

The 300-mm multiple launch rocket system "Smerch" was put into service in 1987 and still has no analogues in the world (Fig. XLVI-L color insert)
The weight of the head part of the MLRS "Smerch" projectile is almost three times greater than that of the American MLRS system. The warhead can be a monoblock or a cassette with 72 combat elements (fragmentation type).
A volley of 12 9M55K missiles with cluster high-explosive fragmentation elements covers an area of 40 hectares.
In addition, incendiary combat elements, anti-tank and anti-personnel mines, as well as some other damaging elements can be used.
MLRS "Smerch" can strike both enemy manpower and armored vehicles, fortifications and command and control posts.
So, for the guaranteed destruction of a motorized infantry company, 10-16 missiles, an artillery battery of 21-44 missiles, and a command center of 4-12 missiles are required. (Fig. LI color insert)
The most vulnerable point of all MLRS, starting with Katyusha, were large deviations, both lateral and in range. Having created the MLRS system, the Americans came to the conclusion that the firing range of 30-40 km is the limit for MLRS. Its further increase leads to too large dispersion of shells.

The Smerch missiles fly at a distance of up to 70 km, and the dispersion in range is only 0.21%, that is, about 150 m, which brings it closer to artillery in accuracy.

How did you manage to achieve such a unique accuracy? The fact is that the Smerch is the world's first multiple launch rocket system with guided missiles, and in addition, the stabilization of the rocket in flight occurs due to its rotation at high speed around the longitudinal axis. Thus, these missiles are also the world's first rotating guided missiles.

Correction of the rocket flight in the pitch and yaw angles is carried out by gas-dynamic rudders, the drives of which are driven by high-pressure gas from the on-board gas generator.

The complex MLRS "Smerch" includes a transport-loading vehicle 9T234-2, created on the chassis of the MAZ-543A vehicle. Transportable ammunition on a transport-loading vehicle - 12 rounds.

An important contribution to improving the combat effectiveness of the Smerch MLRS was made by the Vivarium automated fire control system manufactured by the Kontur production association (Tomsk). The fire control system is located in the back of a van on the chassis of a KAMAZ-4310 Vivarium equipped with an E-715-1.1 computer, and sets flight data for six Smerch MLRS combat vehicles.

Data of MLRS "Smerch"

System	
index Combat vehicle index Combat vehicle	9K58
chassis	9A52-2
Caliber, mm	MAZ-543M
Number of pipes	300
Combat vehicle weight, kg:	12
without shells and calculation	
with shells and calculation	33700
Firing range, km:	43700
maximum	
minimum	70
area of destruction in one salvo, ha	20
Engine type	672
Power, hp. from.	-12A-525A
Highway speed, km / h	525
Fuel range, km	up to 60
Crew, pers.	650
Combat vehicle dimensions, m:	four
length	
width	12.4
height	3.1
	3.1
rocket data rocket	
length, mm	7600
rocket weight, kg	800
warhead weight, kg	280
number of high-explosive fragmentation elements	
in a cluster projectile	72

Further